402-0408-10L High-Field Laser Physics

Allgemeines

Semester	Frühjahrssemester 2010
Dozierende	**H. Reiss**
Periodizität	einmalige Veranstaltung
Lehrsprache	Englisch

Zugehörige Lehrveranstaltungen

Nummer	Titel	Umfang		Dozierende
402-0408-10 V	High-Field Laser Physics	2 Std.	Mi 13-15 HIT F 11.1 »	**H. Reiss**
402-0408-10 U	High-Field Laser Physics	1 Std.	Mi 15-16 HIT F 11.1 »	**H. Reiss**

Katalogdaten

Kurzbeschreibung

The lectures will examine those aspects of classical and quantum electrodynamics that are not normally part of the preparation of an AMO (atomic, molecular, and optical) physicist, but that are fundamental for understanding strong-field phenomena. This includes the behavior of free electrons with laser fields, both classically and quantum mechanically.

Lernziel

Inhalt

The rapid advances in laser capabilities have made available in the laboratory a broad array of electromagnetically induced phenomena that go far beyond previous experience. Atomic, molecular, and optical (AMO) physics is built on the basis of perturbation theory in which the dipole approximation is employed. That is, all phenomena are regarded as being due to electromagnetic fields that are presumed to be weak, and the radiation can be regarded as having a wavelength much greater the size of an individual atom. The modern short-pulse high-field laser has changed all of that in a relatively brief period of time. The result is that much of the physical intuition in the AMO community is outmoded and, in many cases, profoundly misleading.

The lectures on "High-Field Laser Physics" will examine those aspects of classical and quantum electrodynamics that are not normally part of the preparation of an AMO physicist, but that are fundamental for understanding strong-field phenomena. This includes the behavior of free electrons with laser fields, both classically and quantum mechanically. The differences between laser fields and quasistatic electric fields are of special importance because the intense-field regime emphasizes the distinctions between these two types of fields, whereas it is customary in AMO physics to regard the two types of fields as equivalent. This is directly related to the matter of gauge transformations, and the essential distinctions between the so-called length and velocity gauges. The concept of laboratory gauge will be introduced. It is demonstrated that every gauge transformation is associated with an alteration of physical interpretation, which implies that there will be a unique gauge that matches in all respects the laboratory environment. This is the physical gauge. Examples are given of serious qualitative misunderstandings that exist in the literature, arising from this cause.

The fundamentals of quantum mechanics that are necessitated by the intensity-caused failure of perturbation theory is an essential part of the lectures. An exact formalism is demonstrated that is motivated by the basic problem of how quantum measurements are made by instruments that never themselves experience the laser field. This approach, known as S-matrix theory, can provide physical insights di¢ cult to achieve by direct numerical solution of the Schrödinger or Dirac equation.

Laboratory capabilities are now expanding to include the possibility of strong-field experiments with wavelengths that are much longer and much shorter than those currently available. Also novel are the coming capabilities to achieve such high intensities that the "structure of the vacuum"; can be probed. An introduction to the physics of these new environments is provided in the lectures. A treatment of the necessary relativistic quantum mechanics is given in a form that is both more brief and more physical than found in conventional textbooks.

angeboten in	Studiengang	Bereich	Typ
	Physik Master	Auswahl: Quantenelektronik	W

Information zur Leistungskontrolle (gültig bis die Lerneinheit neu gelesen wird)

	Leistungskontrolle als Semesterkurs
ECTS Kreditpunkte	6 KP
Prüfende	**H. Reiss**
Form	Semesterendprüfung
Prüfungssprache	Englisch
Testat erforderlich	Nein
Repetition	Die Leistungskontrolle wird nur am Semesterende nach der Lerneinheit angeboten. Die Repetition ist nur nach erneuter Belegung möglich.
Zusatzinformation zum Prüfungsmodus	oral 20 minutes